PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference ABB/CRC/01/05	**FOR FURTHER ACTION**	See Form PCT/IPEA/416
International application No. PCT/PL2004/000053	International filing date *(day/month/year)* 08.07.2004	Priority date *(day/month/year)* 17.07.2003
International Patent Classification (IPC) or national classification and IPC H02H9/00		
Applicant ABB SP. z o. o. et al.		

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 5 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. ☒ *sent to the applicant and to the International Bureau)* a total of 4 sheets, as follows:
      ☒ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
      ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
   b. ☐ *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

☒	Box No. I	Basis of the opinion
☐	Box No. II	Priority
☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☐	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
☐	Box No. VI	Certain documents cited
☐	Box No. VII	Certain defects in the international application
☐	Box No. VIII	Certain observations on the international application

Date of submission of the demand	Date of completion of this report
01.02.2005	30.05.2005
Name and mailing address of the international preliminary examining authority: European Patent Office - P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Tx: 31 651 epo nl Fax: +31 70 340 - 3016	Authorized Officer Colombo, A Telephone No. +31 70 340-4884

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/PL2004/000053

Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.

   ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
   - ☐ international search (under Rules 12.3 and 23.1(b))
   - ☐ publication of the international application (under Rule 12.4)
   - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)

2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

Description, Pages

3, 4	as originally filed
1, 1bis, 2	received on 01.02.2005 with letter of 27.01.2005

Claims, Numbers

1-5	received on 01.02.2005 with letter of 27.01.2005

Drawings, Sheets

1/2-2/2	as originally filed

☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3. ☐ The amendments have resulted in the cancellation of:
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

* *If item 4 applies, some or all of these sheets may be marked "superseded."*

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-5
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-5
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-5
	No:	Claims	

2. Citations and explanations (Rule 70.7):

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following documents:

D1: DE 12 65 836 B (SIEMENS AG) 11 April 1968
D2: GB-A-1 150 865 (MICAFIL AG) 7 May 1969

1. NOVELTY

1.1 Document D1 is regarded as being the **closest prior art** to the subject-matter of claim 1 and shows (the references in parentheses applying to this document):

a protecting system for medium-voltage potential transformers, comprising an attenuating resistor (R) connected into the open-delta system of three auxiliary secondary windings (wr3, ws3, wt3) of three single-phase transformers (Wr, Ws, Wt), which is deactivated by a switching device (rr, rs or rt) connected in series between the output (U) of the auxiliary secondary winding of one of the single-phase transformers (Wr, Ws, Wt) and the attenuating resistor (R).

1.2 The subject-matter of **claim 1 differs** from this known protecting system in that the switching device has a form of a thermal fuse and is connected in the mentioned series by means of an element with a threshold voltage-current characteristic (the expression "connected by means of" has been interpreted hereby with the only possible meaning of "connected in series with").

1.3 The subject-matter of claim 1 is therefore new (Article 33(2) PCT).

2. INVENTIVE STEP

2.1 The problem to be solved by the present invention may be therefore regarded as how to simplify and use more efficiently the known protection systems for voltage transformers, avoiding unnecessary heating of the damping resistor during normal service condition and any unnecessary wiring.

2.2 The solution proposed in claim 1 is not anticipated or suggested by the prior art. The

use of a thermal fuse for avoiding additional wirings on the secondary side is not mentioned or disclosed by any available document. In D2 only the task of reducing the heating of the resistor is considered, but it is solved with a different and more complex arrangement (namely a switching element triggered by an additional circuit).

2.3 Claim 1 is therefore considered as involving an inventive step (Article 33(3) PCT).

3 DEPENDENT CLAIMS

Claims 2-5 are dependent on claim 1 and as such also meet the requirements of the PCT with respect to novelty and inventive step.

4. INDUSTRIAL APPLICABILITY

The subject-matter of the present application relates to protecting devices for components to be used in electrical installations. The requirements of Article 33(4) PCT regarding the industrial applicability are therefore fulfilled.

A protection system for medium-voltage potential transformers

The subject of the invention is a protection system for medium-voltage potential transformers, finding application in the attenuation of ferroresonant states occurring in at least one of three potential transformers in a three-phase medium-voltage network.

For the attenuation of ferroresonant states in electrical equipment, and especially in potential transformers, a protecting resistor of a resistance of several dozen ohms is typically used. Such a resistor is connected to three auxiliary secondary windings of three single-phase transformers forming an open delta system. Though this solution employs a simple design, it has significant disadvantages. In case of sustained unbalance in the supply network, the small resistance value of the protecting resistor, which is required for the effectiveness of ferroresonant oscillation attenuation, brings about the danger of thermal damage to the transformer or the resistor itself. In practice, attenuating resistors of powers of several hundred watts and of large dimensions are used.

The solution to the thermal problem related to the presence of the damping resistor in the case of significant network asymmetry resulting form a prolonged earthfault was presented in DE 1265836, describing a circuit for damping ferroresonant oscillations, in which the damping resistor is connected to the open-delta arranged auxiliary windings of the three single-phase voltage transformers by means of working contacts of a relay or relays, which are connected to the secondary windings of the voltage transformers. The disadvantage of such a solution is that it requires additional wiring between the coils of the relays and the secondary windings of the voltage transformers. Another disadvantage of this solution is that in the case of a

small network asymmetry resulting from e.g. unbalanced load, the zero-sequence voltage will result in current flow through the resistor, as it may be disconnected only in the case of an earth-fault condition. This may result in unnecessary heating of the resistor as well as in loading of the voltage transformers during normal service conditions, as the circuit described does not contain a temperature-sensitive element. The problem how to avoid the presence of the damping load during the normal service condition was presented in GB 1150865, describing a controlled anti-ferroresonance circuit for a single-phase capacitive voltage transformer, including a damping burden, a gate-controlled a.c. semiconductor switch arranged to connect the damping burden to the intermediate voltage transformer when the switch is conductive, and triggering means for rendering the switch conductive throughout occurrence of unwanted oscillations. The disadvantage of the solution is that it requires means for detecting the unwanted oscillations in order to provide the triggering signal making the semi-conducting switch conductive for a pre-defined time necessary to damp the unwanted oscillations.

PTC resistors, bimetallic circuit breakers or thermal fuses are commonly used to protect electrical equipment against thermal damage caused, for example, by voltage overload.

For example, a module protecting a telecommunication system, which consists of a PTC thermistor connected in series into the subscriber's line winding and a thyristor diode which is connected in parallel between the subscriber's line winding and ground is known from a German patent application No. 3621200. If undesired voltage appears in the subscriber's line, then current flowing through the thyristor diode heats it up and consequently the thermistor is heated up as well, because the diode is thermally

connected with the PTC thermistor. As a result, the thermistor resistance increases and the voltage overload is reduced.

The essence of the medium-voltage potential transformers protection system comprising an attenuating resistor connected into the open delta system of three auxiliary secondary windings of three single-phase transformers, which is deactivated by a switching device is that the switching device has a form of a thermal fuse, which is connected in series between the output of the auxiliary secondary winding of one of the single-phase transformers and the attenuating resistor by means of an element with a threshold voltage and current characteristic.

Preferably the thermal fuse has the form of a bimetallic circuit breaker, and the element with threshold voltage and current characteristic has the form of two Zener diodes push-pull connected with one another.

As an alternative, the thermal fuse has the form of a PTC resistor, and the element with the threshold characteristic has the form of two Zener diodes push-pull connected with one another.

Preferably the thermal fuse is a PTC resistor, and the element with the threshold characteristic is a varistor.

As an alternative, the thermal fuse is a bimetallic circuit breaker, and the element with the threshold voltage and current characteristic is a varistor.

The advantage of the inventive system is that it assures the attenuation of ferroresonant oscillations while being insensitive to small values of zero-sequence voltage, which occur in case of small unbalance in a three-phase network. In case of sustained zero-sequence voltage, for instance one generated as a result of an earth fault of one of the phases, the use of a thermal fuse provides additional protection of the transformers and of the elements of the protection system that protects the transformers against damage. The use of the thermal protection allows to decrease the thermal power of the attenuating resistor compared to earlier solutions. That is why the inventive system is efficient and its dimensions are small compared to existing protecting devices.

The subject of the invention is presented in an embodiment in the drawing, where fig. 1 shows a system of potential transformers connected to a protecting system, fig. 2 – the first variant of the protecting system embodiment FDC1, fig. 3 – the second variant of the protecting system embodiment FDC2, fig. 4 – the third variant of the protecting

Claims

1. A protecting system for medium-voltage potential transformers , comprising an attenuating resistor (R1) connected into the open delta system of three auxiliary secondary windings of three single-phase transformers (VT1, VT2, VT3), which is deactivated by a switching device characterized in that the switching device has a form of a thermal fuse (2) which is connected in series between the output of the auxiliary secondary winding of one of the single-phase transformers (VT1 , VT2, VT3) and the attenuating resistor (R1) by means of an element with a threshold voltage and current characteristic (1).
2. A system according to claim 1, **characterised in that** the thermal fuse (2) has the form of a bimetallic circuit breaker (TF1), and the element with a threshold voltage and current characteristic has the form of two Zener diodes (D1, D2), push-pull connected with one another.
3. A system according to claim 1, **characterised in that** the thermal fuse (2) has the form of a PTC resistor, and the element with a threshold voltage and current characteristic has the form of two Zener diodes push-pull connected with one another.
4. A system according to claim 1, **characterised in that** the thermal fuse (2) is a PTC resistor, and the element with a threshold voltage and current characteristic is a varistor.
5. A system according to claim 1, **characterised in that** the thermal fuse (2) is a bimetallic circuit breaker (TF1), and the element with a threshold voltage and current characteristic is a varistor.